WHAT IS CLAIMED IS:

1. A nitride-based semiconductor device comprising:

a first nitride semiconductor layer doped with an n type impurity;

an active layer formed on the first nitride semiconductor layer, the active layer including a plurality of quantum well layers and a plurality of quantum barrier layers alternately laminated over one another, at least one of the quantum layers being doped with the n type impurity; and

a nitride semiconductor layer formed over the active layer, and doped with a p type impurity,

wherein the at least one quantum barrier layer doped with the n type impurity includes an internal layer portion doped with the n type impurity, and an anti-diffusion film arranged at an interface of the quantum barrier layer with an adjacent one of the quantum well layers, the anti-diffusion film having an n type impurity concentration lower than that of the internal layer portion.

2. The nitride-based semiconductor device according to claim 1, wherein each of the quantum barrier layers is made of $Al_{x1}In_{y1}Ga_{1-x1-y1}N$ ($x_1 + y_1 = 1$, $0 \leq x_1 \leq 1$, $0 \leq y_1 \leq 1$), and each of the quantum well layers is made of $Al_{x2}In_{y2}Ga_{1-x2-y2}N$ ($x_2 + y_2 = 1$, 0

$\leq x_2 \leq 1$, $0 \leq y_2 \leq 1$) having an energy band gap smaller than that of the quantum barrier layers.

3. The nitride-based semiconductor device according to claim 1, wherein the n type impurity is at least one material selected from a group consisting of Si, Ge, and Sn.

4. The nitride-based semiconductor device according to claim 1, wherein the n type impurity concentration of the anti-diffusion film is 50% or less of the n type impurity concentration of the doped internal layer portion in the associated quantum barrier layer.

5. The nitride-based semiconductor device according to claim 1, wherein the n type impurity concentration of the internal layer portion in the at least one quantum barrier layer doped with the n type impurity is about $3 \times 10^{16}/cm^3$ to about $3 \times 10^{19}/cm^3$.

6. The nitride-based semiconductor device according to claim 1, wherein the anti-diffusion film in the at least one quantum barrier layer is not doped intentionally with n type impurity.

7. The nitride-based semiconductor device according to claim 1, wherein the at least one quantum barrier layer doped with the n type impurity comprises one or both of the quantum barrier layers respectively contacting the first and second nitride semiconductor layers while having anti-diffusion films arranged at respective interfaces of the quantum barrier layers with the first and second nitride semiconductor layers.

8. The nitride-based semiconductor device according to claim 1, wherein the at least one quantum barrier layer doped with the n type impurity comprises at least one of the quantum barrier layers each interposed between adjacent ones of the quantum well layers while having anti-diffusion films arranged at respective interfaces of the quantum barrier layer with the adjacent quantum well layers.

9. The nitride-based semiconductor device according to claim 1, wherein the anti-diffusion film of the at least one quantum barrier layer doped with the n type impurity has a thickness corresponding to about 10% to about 40% of the thickness of the quantum barrier layer.

10. The nitride-based semiconductor device according to claim 9, wherein:

the thickness of the at least one quantum barrier layer doped with the n type impurity is about 3nm to about 30nm; and

the thickness of the anti-diffusion film is about 0.3nm to about 10nm.

11. The nitride-based semiconductor device according to claim 1, wherein:

the at least one quantum barrier layer doped with the n type impurity comprises two or more of the quantum barrier layers included in the active layer; and

at least one of the two or more quantum barrier layers has an n type impurity concentration different from those of the other quantum barrier layers.

12. The nitride-based semiconductor device according to claim 11, wherein the two or more quantum barrier layers have different n type impurity concentrations, respectively, such that the quantum barrier layer contacting the first nitride semiconductor layer has a highest n type impurity concentration, and the remaining quantum barrier layers exhibit a lower n type impurity concentration at a more adjacent one thereof to the second nitride semiconductor layer.

13. The nitride-based semiconductor device according to

claim 11, wherein the anti-diffusion films of the two or more quantum barrier layers have n type impurity concentrations proportional to the concentrations and/or thicknesses of the two or more quantum barrier layers, respectively.

14. The nitride-based semiconductor device according to claim 11, wherein the anti-diffusion films of the two or more quantum barrier layers have thicknesses proportional to the concentrations and/or thicknesses of the two or more quantum barrier layers, respectively.